

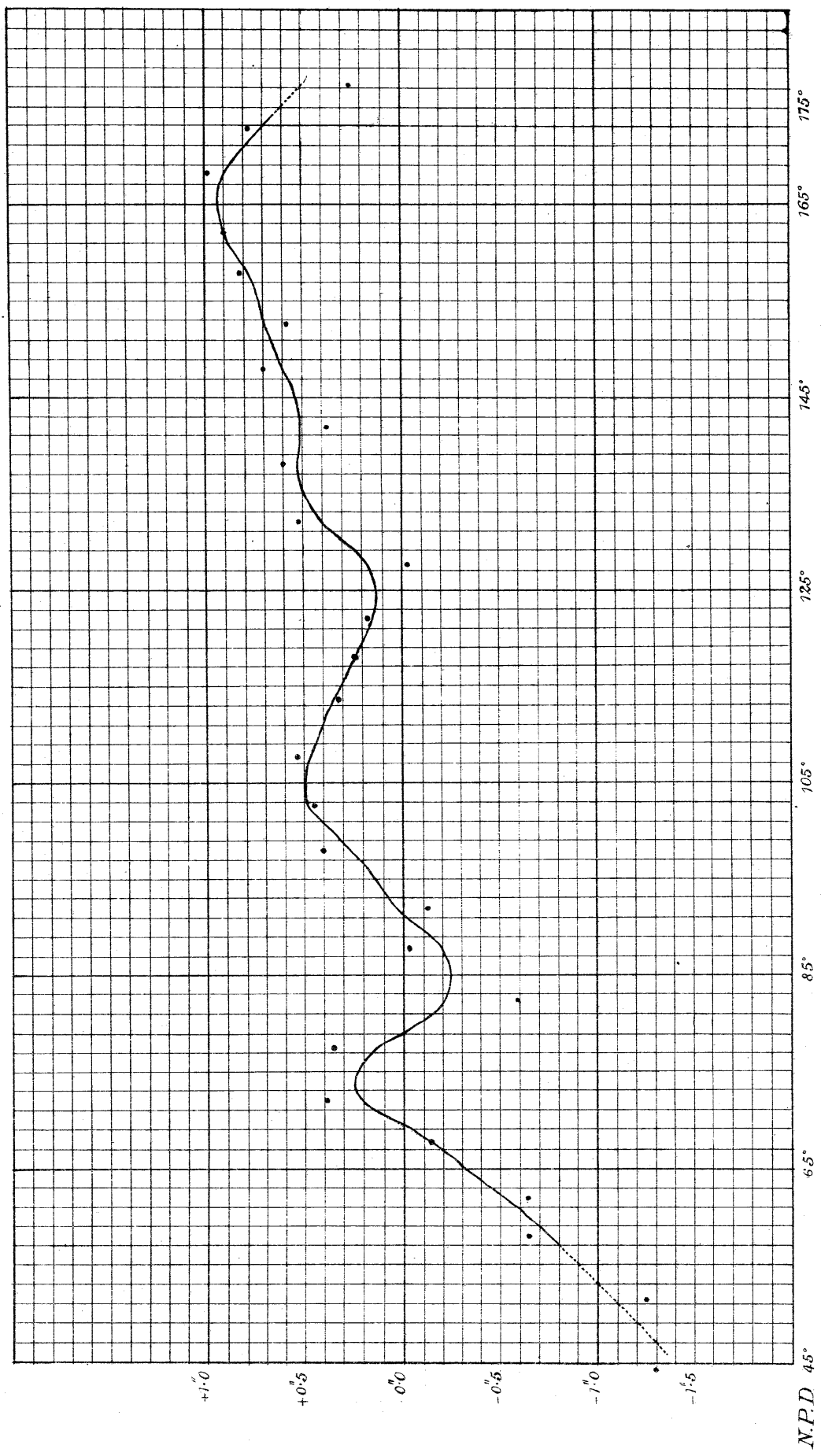
On the North Polar Distances of the Cape Catalogue for 1880, and on the Greenwich and Cape Mean Systems of North Polar Distances. By A. M. W. Downing, M.A.

The chief difficulty to be encountered in discussing the North Polar Distances of the Cape Catalogue for 1880 is the uncertainty in the values of the proper motions of the great mass of southern stars. It is on this account that I have selected for comparison with this catalogue the Melbourne Catalogue for 1870, as being nearest in date of any southern catalogue. There are 911 stars common to the catalogues which are available for the comparison, and it is reasonable to suppose that when such a large number of stars is used the results will be sensibly free from error arising from the assumption of erroneous proper motions.

The assumed proper motions have been taken from the Cape Catalogue itself, or from the list of additional proper motions given at the end of the catalogue, or from the Melbourne Catalogue, or from the Cape Catalogues for 1860 or 1840; but a large number of the stars have necessarily been used with assumed proper motion = 0. In order to show that this proceeding has not had an appreciable effect on the computed differences between the N.P.D.'s of the catalogues, when taken in groups extending over 5° of N.P.D., I have given the probable errors of a difference between the catalogue places for each group; and it appears that there is no decided increase in these probable errors in passing from stars which are observable in the northern hemisphere, and whose proper motions are known with comparative certainty, to the stars which are situated beyond the reach of northern observers.

Only one star out of the whole number has been rejected for discordance. This is Lacaille 4342, which is No. 5595 in the Cape Catalogue and No. 511 in the Melbourne Catalogue, but its place (as far as I know) is not given in any other catalogue. The difference Cape *minus* Melbourne amounts to $+4''.69$, and as its N.P.D. in each catalogue depends on a considerable number of observations, and the mean dates of observation in the Cape and Melbourne Catalogues are 1871.5 and 1868.7 respectively, it is reasonable to suppose that this star has a large proper motion in N.P.D. In fact, Lacaille's place compared with that in the Cape Catalogue gives for proper motion $+0''.8$. I commend this star to the attention of H.M. Astronomer at the Cape.

The places in the Cape Catalogue have been brought back to 1870, and the differences Cape *minus* Melbourne taken. The differences have then been combined in groups of 5° , and the means of each group and the mean N.P.D. of each group found. These mean differences have been laid down as points on cross-ruled paper, and a curve (*see* diagram) drawn through them, which may be taken to represent the systematic differences between the N.P.D.'s of the catalogues.



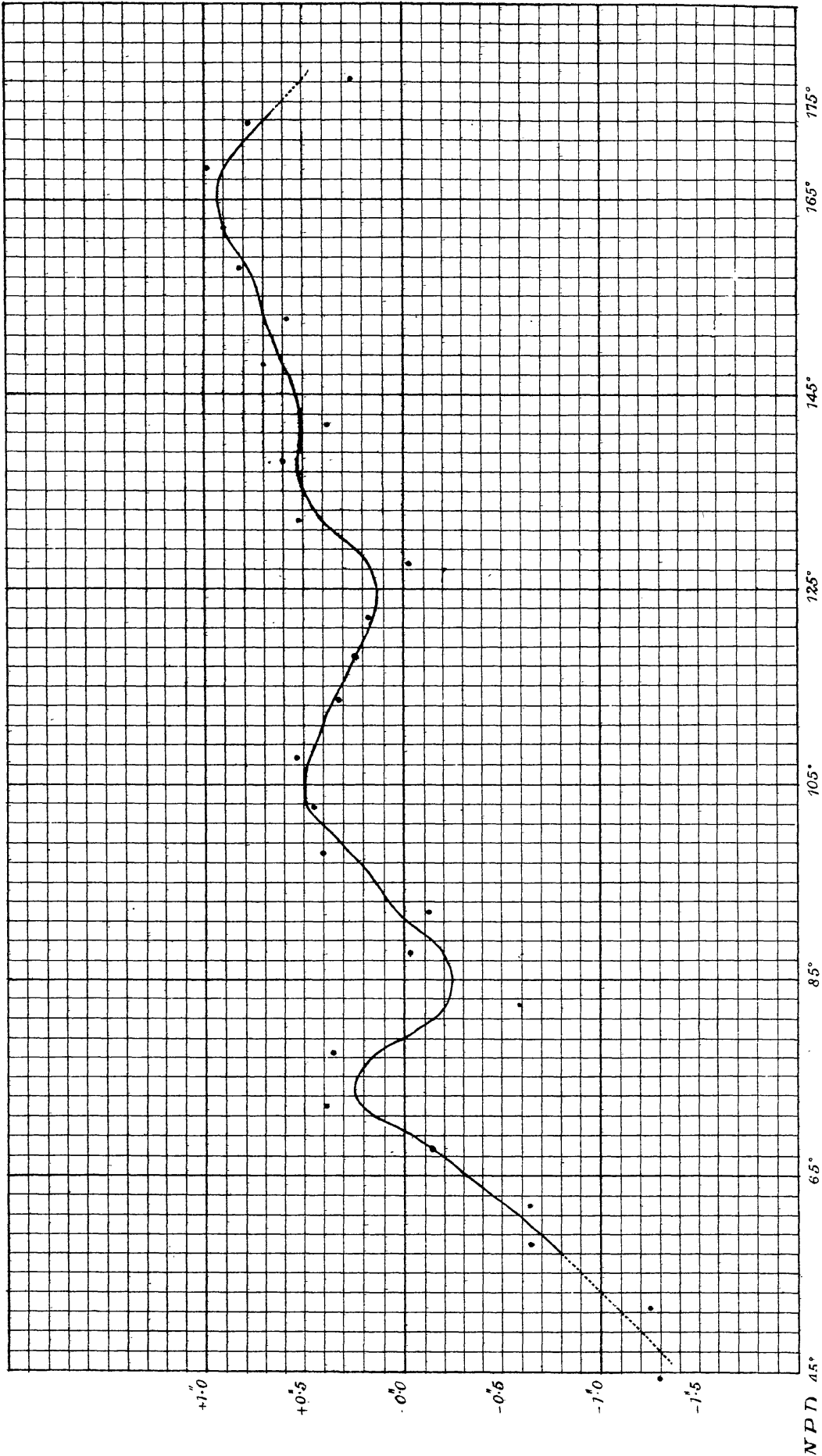
Stottiswoode & Co Lith London

The following table gives the differences, corresponding to the mean N.P.D. of each group, as computed and as read off from the curve. The column under ϵ_1 is the probable error of a single difference between the positions as given in the catalogues, and is found from the discordance of each separate difference from the mean of the group. There are not a sufficient number of observations of stars north of N.P.D. 60° in the Cape Catalogue (such observations being of course foreign to the plan of the work) to enable us to determine with any accuracy the systematic differences between the catalogues, for stars situated near the northern horizon of the Observatories:—

N.P.D.	Number of Stars.	Cape—Melbourne Means.	ϵ_1	Cape—Melbourne Curve.
$44^\circ 38'$	2	$-1'30''$	—	—
$51^\circ 11'$	2	$-1'25''$	—	—
$57^\circ 41'$	4	$-0'63''$	—	—
$62^\circ 4'$	8	$-0'64''$	$\pm 0'46''$	$-0'51''$
$67^\circ 57'$	9	$-0'12''$	$'54$	$-0'12''$
$72^\circ 6'$	8	$+0'39''$	$'32$	$+0'21''$
$77^\circ 3'$	12	$+0'36''$	$'56$	$+0'13''$
$82^\circ 31'$	15	$-0'60''$	$'59$	$-0'22''$
$87^\circ 34'$	11	$-0'03''$	$'38$	$-0'20''$
$91^\circ 45'$	14	$-0'12''$	$'49$	$+0'03''$
$97^\circ 59'$	7	$+0'40''$	$'32$	$+0'27''$
$102^\circ 42'$	7	$+0'45''$	$'30$	$+0'47''$
$107^\circ 27'$	11	$+0'54''$	$'42$	$+0'47''$
$113^\circ 15'$	10	$+0'32''$	$'35$	$+0'36''$
$117^\circ 28'$	37	$+0'26''$	$'50$	$+0'26''$
$122^\circ 21'$	38	$+0'18''$	$'62$	$+0'15''$
$127^\circ 32'$	65	$-0'02''$	$'54$	$+0'17''$
$132^\circ 7'$	71	$+0'52''$	$'60$	$+0'41''$
$137^\circ 25'$	61	$+0'60''$	$'49$	$+0'53''$
$141^\circ 48'$	32	$+0'38''$	$'44$	$+0'52''$
$147^\circ 59'$	46	$+0'70''$	$'46$	$+0'60''$
$152^\circ 31'$	208	$+0'59''$	$'49$	$+0'68''$
$157^\circ 46'$	130	$+0'82''$	$'52$	$+0'78''$
$161^\circ 57'$	18	$+0'91''$	$'52$	$+0'91''$
$168^\circ 8'$	29	$+0'99''$	$'56$	$+0'92''$
$172^\circ 39'$	41	$+0'78''$	$'39$	$+0'72''$
$177^\circ 1'$	15	$+0'26''$	$'23$	—

The average probable error of a difference between the N.P.D.'s of the catalogues is $\pm 0''\cdot46$. From a comparison of the Green-

Comparison of the North Polar Distances of the Cape (1880) and Melbourne (1870) Catalogues.



wich (1864) and Melbourne (1870) Catalogues (*Vierteljahrs-schrift*, Bd. xi. S. 187) Prof. Gylden found the probable error of a difference between the N.P.D.'s of these Catalogues, for stars situated in the zone 60° — 110° N.P.D., to be $\pm 0''\cdot30$. The larger probable error found above can hardly be attributed to the use of inaccurate proper motions, for confining ourselves to stars situated between 60° and 110° N.P.D., the average probable error of a difference is $\pm 0''\cdot44$. It would appear, therefore, that the probable accidental errors of the N.P.D.'s of the Cape Catalogue for 1880 are somewhat larger than those of the Greenwich Catalogue for 1864.

By reading off from the curve given above the differences corresponding to every 4° of N.P.D., and making use of the comparisons given in my papers in the *Monthly Notices* for December 1878, January 1879, and January 1881, we get the following corrections applicable to the N.P.D.'s of the several catalogues named to reduce them to the system of the Cape Catalogue for 1880; except that for the Cape Catalogue (1833) the data in Mr. Boss's *Declinations of Fixed Stars* have been used from N.P.D. 60° to N.P.D. 120° inclusive.

N.P.D.	Cape (1833).	Cape (1840).	Cape (1860).	Melbourne (1870).	Greenwich Mean System.
60°	-0"88	+0"08	-0"30	-0"65	-0"71
64	-0"96	-0"10	-0"35	-0"40	-0"74
68	-0"78	-0"08	-0"21	-0"11	-0"59
72	-0"35	+0"25	+0"08	+0"20	-0"31
76	-0"13	+0"14	+0"13	+0"19	-0"23
80	-0"17	-0"33	-0"05	-0"08	-0"37
84	-0"27	-0"89	-0"20	-0"24	-0"51
88	-0"44	-1"32	-0"36	-0"19	-0"72
92	-0"26	-1"19	-0"11	+0"03	-0"51
96	-0"26	-1"08	0"00	+0"17	-0"45
100	-0"27	-0"84	+0"15	+0"35	-0"30
104	-0"39	-0"48	+0"22	+0"49	-0"13
108	-0"57	-0"09	+0"21	+0"47	+0"01
112	-0"81	+0"03	+0"10	+0"40	+0"07
116	-1"11	-0"30	-0"14	+0"29	-0"10
120	-1"22	-0"56	-0"27	+0"19	-0"12
122	-1"51	-0"60	-0"28	+0"16	+0"05
124	-1"40	-0"50	-0"23	+0"14	-0"54
128	-1"06	-0"19	-0"10	+0"18	
132	-0"59	+0"05	-0"06	+0"41	
136	-0"32	+0"08	-0"21	+0"51	
140	-0"03	+0"23	-0"18	+0"52	

Nov. 1881.

of the Cape Catalogue etc.

23

N.P.D.	Cape (1833).	Cape (1840).	Cape (1860).	Melbourne (1870).	Greenwich Mean System.
144 ⁰	-0 ["] 18	+0 ["] 21	-0 ["] 23	+0 ["] 53	
148	+0 ["] 09	+0 ["] 38	-0 ["] 09	+0 ["] 60	
152	+0 ["] 61	+0 ["] 77	+0 ["] 17	+0 ["] 67	
156	+0 ["] 76	+1 ["] 11	+0 ["] 30	+0 ["] 74	
160	+0 ["] 75	+1 ["] 25	+0 ["] 43	+0 ["] 84	
164	+0 ["] 95	+1 ["] 29	+0 ["] 59	+0 ["] 93	
168	+1 ["] 11	+1 ["] 06	+0 ["] 64	+0 ["] 91	
172	+0 ["] 99	+0 ["] 69	+0 ["] 56	+0 ["] 75	
176	+0 ["] 75	+0 ["] 59	+0 ["] 45	+0 ["] 57	

The Greenwich "Mean System" is found by taking the simple mean of the comparisons of six Greenwich Catalogues with the Melbourne Catalogue given by the Astronomer Royal on page 172 of vol. xlv. of the *Memoirs*, Bessel's refractions with Main's corrections below Z.D. 82° being used in all cases.

The above comparison with the Cape Catalogue for 1860 is very satisfactory, showing as it does that the systematic errors of the catalogues do not differ by any considerable amount, except perhaps for the circumpolar stars. It will be remembered that the south latitude of the Observatory adopted in the several catalogues was, for the 1833 Catalogue 33° 56' 3''·20, for the 1840 Catalogue 33° 56' 3''·25, for the 1860 Catalogue 33° 56' 3''·56, and for the 1880 Catalogue 33° 56' 3''·41. The refractions used were those of Bessel's *Tabulæ Regiomontaneæ*, except that for the period during which the observations included in the last-mentioned catalogue were made it was found that the thermometer read 0°·55 too high, so that Bessel's mean refractions were really diminished in the proportion 0·9988 : 1. I can find no information with regard to the errors of the thermometer for the periods corresponding to the other catalogues.

The following table gives the corrections applicable to the approximation to a Mean System formed from the Cape Catalogues for 1840, 1860, and 1880, to reduce them to the Greenwich Mean System as given above:—

N.P.D.	Greenwich - Cape.	N.P.D.	Greenwich - Cape.
60	+0 ["] 64	96	+0 ["] 09
64	+0 ["] 59	100	+0 ["] 06
68	+0 ["] 49	104	+0 ["] 04
72	+0 ["] 42	108	+0 ["] 03
76	+0 ["] 32	112	-0 ["] 03
80	+0 ["] 24	116	-0 ["] 05
84	+0 ["] 15	120	-0 ["] 17
88	+0 ["] 13	122	-0 ["] 34
92	+0 ["] 08	124	+0 ["] 30

This, in common with my previous comparisons of Greenwich and Cape results, seems to indicate that there is a systematic error affecting the Cape N.P.D.'s near the north horizon, and increasing as we approach the horizon (probably the effect of uncorrected flexure), which makes the observed Z.D.'s too large. A definite decision on this point cannot, however, be arrived at with the materials at present at our disposal. But much light will be thrown on the subject by the publication of a limited fundamental catalogue, in which special attention is paid to such points as latitude, refraction, flexure, and discordance of direct and reflexion observations. I understand that the staff of the Cape Observatory are now employed on the observations necessary for the formation of such a catalogue.

The residuals given above, when laid down as points on cross-ruled paper, so nearly lie on a right line that from N.P.D. 60° to 120° they may be closely represented by the expression

$$+ 0''.20 \sin \text{N.P.D.} + 0''.675 \cos \text{N.P.D.} \quad (\text{I.})$$

If, however, it be assumed that the residuals between N.P.D. 60° and 112° arise from errors in the Cape Z.D.'s they may be very fairly represented by

$$+ 0''.74 \sin \text{Z.D.} - 0''.26 \cos \text{Z.D.} \quad (\text{II.})$$

as will be seen from the following tabular statement :—

N.P.D.	Greenwich—Cape.		Excess of	
	Formula (I.).	Formula (II.).	Formula (I.).	Formula (II.).
60°	+ 0''.51	+ 0''.55	— 0''.13	— 0''.09
64	.48	.51	.11	.08
68	.44	.47	.05	— .02
72	.40	.42	— .02	.00
76	.36	.38	+ .04	+ .06
80	.31	.32	.07	.08
84	.27	.28	.12	.13
88	.22	.23	.09	.10
92	.18	.17	.10	.09
96	.13	.12	.04	+ .03
100	.08	.06	+ .02	.00
104	+ .03	+ .01	— .01	— .03
108	— .02	— .05	.05	.08
112	.07	— .10	.04	— .07
116	.10	—	— .05	—
120	— .17	—	.00	—

The last two columns give the differences of the residuals found from each of the formulæ and from the means of the catalogue comparisons given in the previous table.

With the exception of the discordance referred to above, the close agreement between the N.P.D.'s found from the Greenwich and Cape observations is very remarkable.

1881, November 5.

Ephemeris for finding the Positions of the Satellites of Uranus, 1882.
By A. Marth, Esq.

In October the Earth has passed through the planes of the orbits of the satellites of *Uranus* from the side on which it had been since 1840 to the other side, on which the satellites appear to move in the direction of increasing position-angles, and on which, after returning next spring for some months to the former side, it will remain till the year 1923. In view of the importance of securing series of observations of the satellites during the present apparition of the planet, the ephemeris is made to begin a month earlier than would otherwise be necessary.

The angle of position p_0 of the major axes, the major and minor semiaxes a and b of the apparent ellipses described by the satellites, and the latitude of the Earth above the assumed plane of their orbits, are the following:—

Greenwich Noon. 1881.	<i>Ariel.</i>			<i>Umbriel.</i>		<i>Titania.</i>		<i>Oberon.</i>		Lat. of Earth.
	p_0	a_1	b_1	a_2	b_2	a_3	b_3	a_4	b_4	
Dec. 10	15°24	14°52 + 0°67	20°22 + 0°94	33°17 + 1°53	44°35 + 2°05	+ 2°65				
20	15°25	14°63	0°70	20°37	0°97	33°42	1°59	44°69	2°13	2°73
30	15°25	14°76	0°70	20°56	0°98	33°73	1°60	45°11	2°14	2°72
1882. Jan. 9	15°24	14°89 + 0°68	20°74 + 0°95	34°02 + 1°55	45°50 + 2°07	+ 2°61				
19	15°22	15°01	0°63	20°91	0°88	34°30	1°45	45°86	1°93	2°42
29	15°20	15°11	0°57	21°05	0°79	34°53	1°29	46°18	1°73	2°15
Feb. 8	15°17	15°19	0°48	21°17	0°67	34°72	1°10	46°43	1°47	1°81
18	15°14	15°25	0°38	21°25	0°53	34°86	0°87	46°61	1°16	1°42
28	15°10	15°29	0°27	21°30	0°37	34°93	0°61	46°72	0°82	1°00
Mar. 10	15°06	15°29	0°15	21°31	0°21	34°95	0°35	46°74	0°47	0°57
20	15°01	15°27 + 0°04	21°28 + 0°06	34°90 + 0°09	46°68 + 0°12	+ 0°15				
30	14°97	15°23 - 0°07	21°21 - 0°09	34°80 - 0°15	46°53 - 0°21	- 0°25				
Apr. 9	14°93	15°16	0°16	21°12	0°23	34°64	0°37	46°32	0°50	0°61
19	14°90	15°07	0°24	20°99	0°34	34°43	0°55	46°04	0°74	0°92
29	14°88	14°96	0°30	20°84	0°42	34°18	0°69	45°71	0°92	1°15
May 9	14°86	14°84	0°34	20°67	0°47	33°91	0°77	45°35	1°03	1°31
19	14°85	14°71	0°35	20°49	0°49	33°61	0°80	44°95	1°07	1°38
29	14°85	14°58 - 0°35	20°31 - 0°48	33°31 - 0°79	44°55 - 1°06	- 1°36				